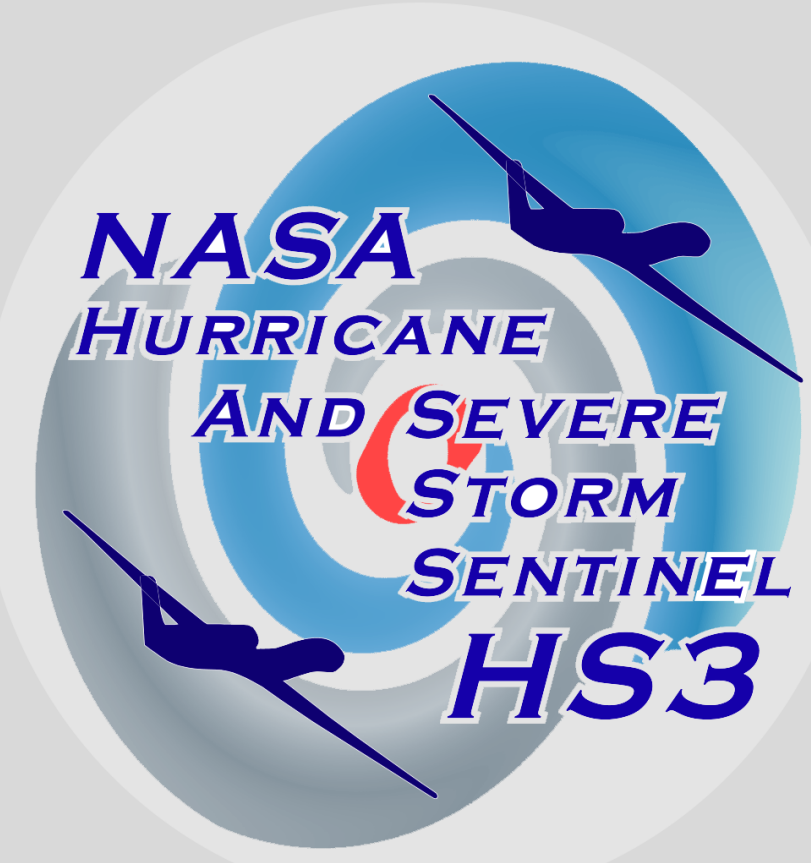




A Preliminary Look at a Tropical Convective System Phase Space

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Introduction

- Several recent studies have documented observed tropical convective system (TCS) evolution and structure
 - e.g. Davis and Ahijevych (2012, 2013), Helms (2012), Komaromi (2012), Zawislak and Zipser (2013)
- The present study aims to build on these studies by exploring the **possibility of TCS structure modulating the interactions between the system and its environment** using the phase space presented here.
 - Phase space metrics identify similar systems located in similar environments
 - Trajectories in phase space depict system evolution
- It is hoped that the TCS phase space will provide a **potentially useful tool for tropical cyclogenesis forecasting**
 - Similar to Hart (2003) and Wheeler and Hendon (2004)

Data and TCS Tracking

- Methodology is being evaluated using the 0.5° resolution Climate Forecast System Reanalysis (Saha et al. 2010)
- Additional datasets to be processed at a future date
- Domain currently covers North Atlantic basin equatorward of 30°N during the Atlantic hurricane season (June–November)
- Candidate TCS center fixes are identified by maxima in mean 850 hPa vortex idealization (\mathcal{I} ; Eq. 1)
 - Vortex idealization is positive in directionally cyclonic flow** and is not directly dependent on intensity
 - $\mathcal{I} = 100\%$ indicates nondivergent, cyclonic flow

Definition of Vortex Idealization

$$\mathcal{I} = \frac{V_{\lambda}}{\|\vec{V}\|} \quad (1)$$

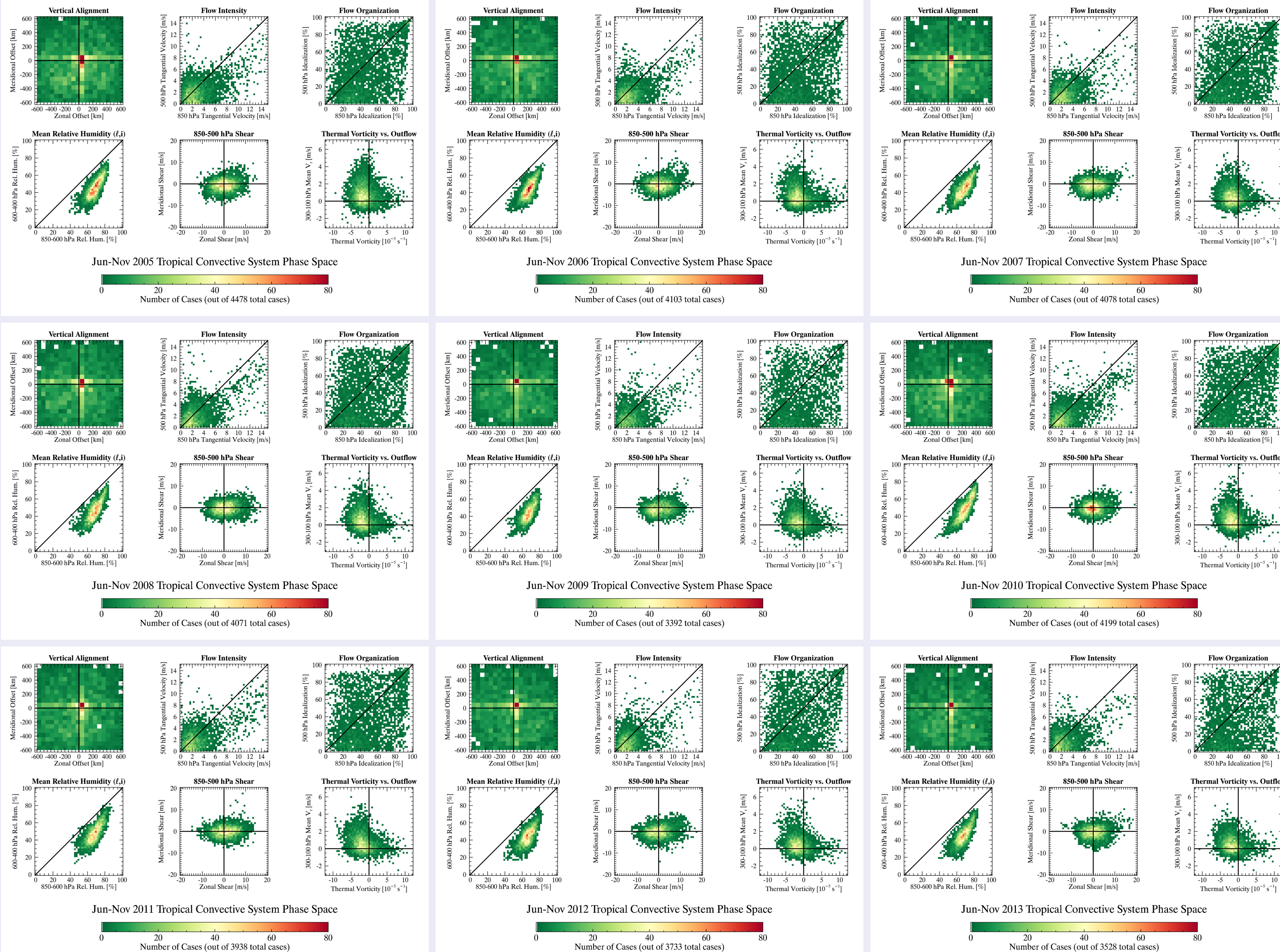
V_{λ} : tangential velocity; \vec{V} : total wind

- Tracks are produced using 850–600-hPa mean steering flow at 500-km radius
- A TCS is considered as developing if it is located within 500 km of an IBTrACS (Knapp et al. 2010) tropical cyclone
- A track is accepted if it has a lifespan $\geq 24h$, spends at least 48 hours over water ($\geq 50\%$ for lifespans $< 48h$), and simultaneously meets all of the following criteria while over water (distances from 850-hPa center):

700-hPa $\bar{\omega} \geq 20\%$ within 333 km
500-hPa $\bar{\omega} \geq 0\%$ within 555 km
850-hPa $\bar{V}_{\lambda} \geq 0 \text{ m s}^{-1}$ within 555 km
Sfc. $\nabla p \geq 0 \text{ Pa m}^{-1}$ within 555 km
850-hPa RH $\geq 50\%$ covering $\geq 90\%$ 333-km radius area
700-hPa RH $\geq 50\%$ covering $\geq 75\%$ 333-km radius area
500-hPa RH $\geq 50\%$ covering $\geq 10\%$ 333-km radius area

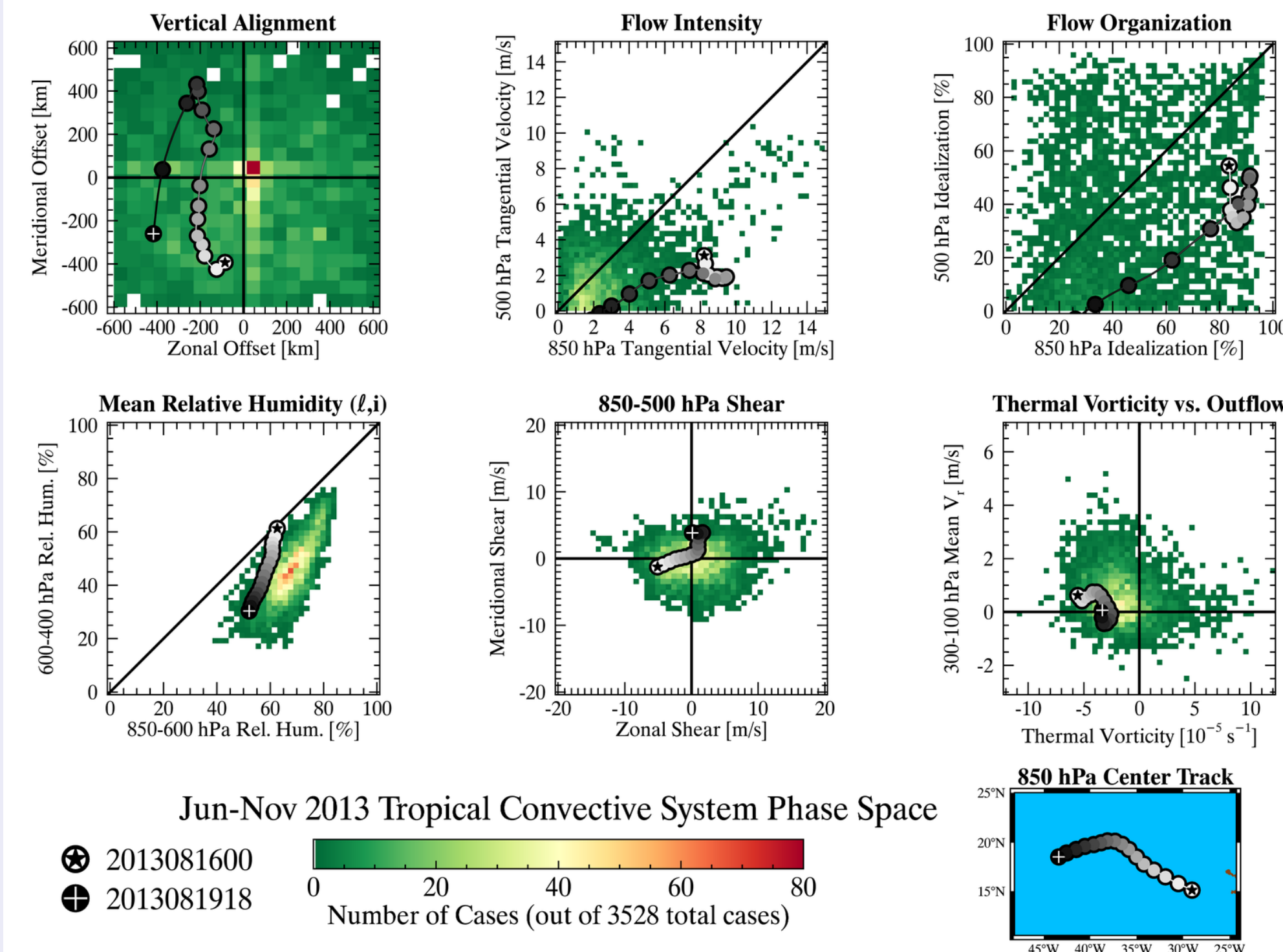
2005–2013 Phase Space Distributions

- Distributions of all North Atlantic systems tracked for a given year (nondeveloping, pregenesis, and postgenesis)

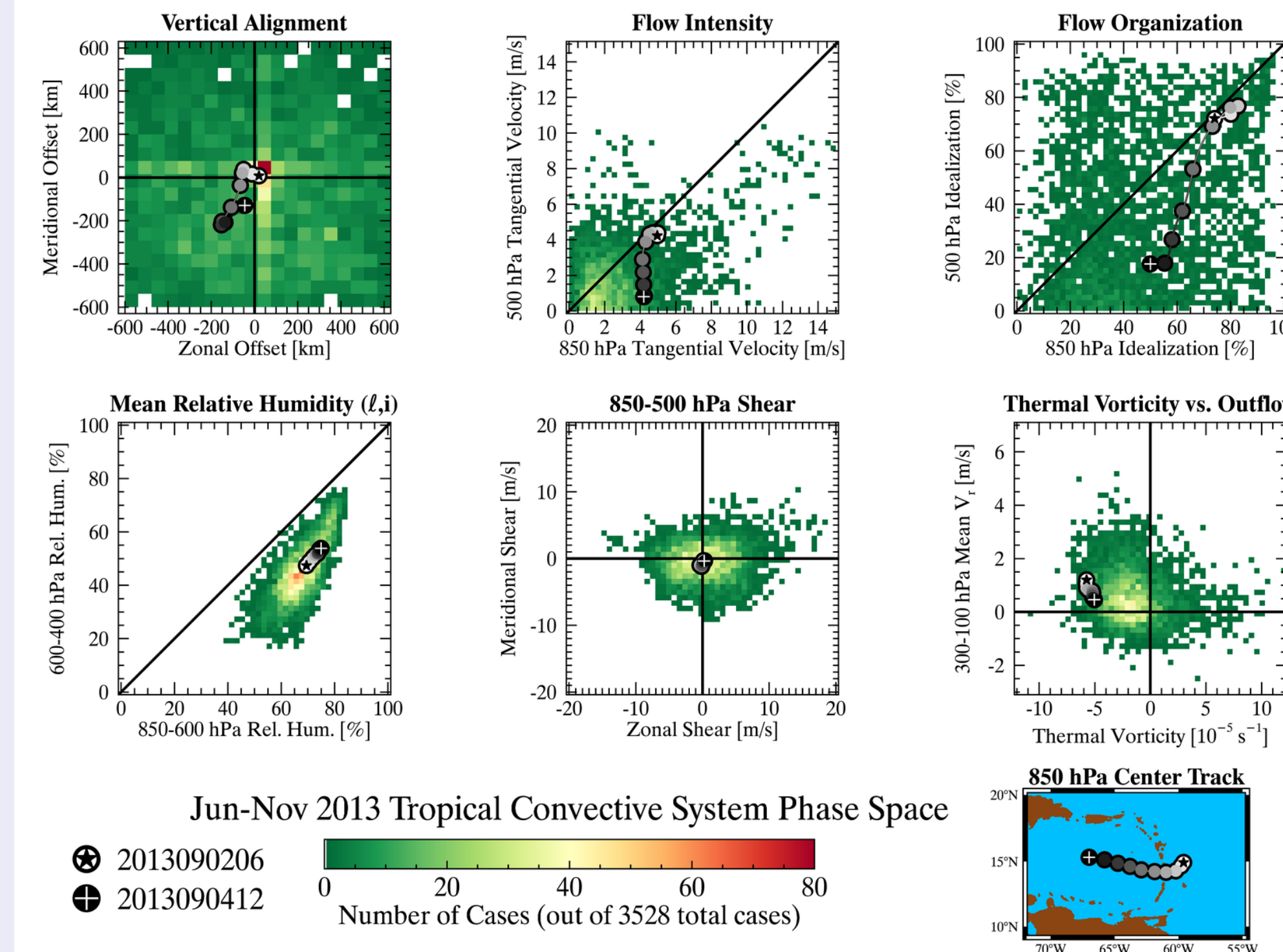


2013 Phase Space Trajectories

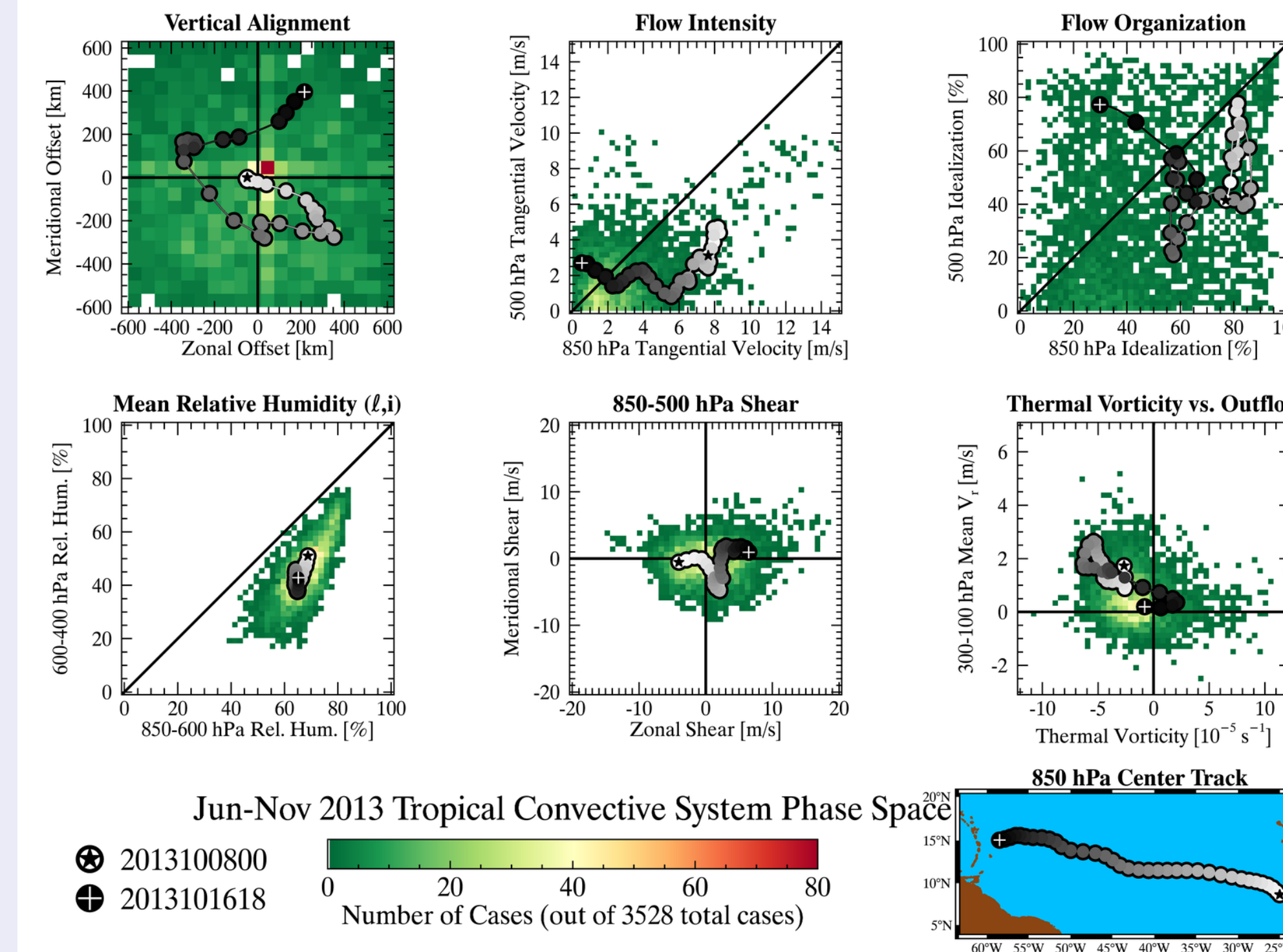
Erin (2013) - Postgenesis Evolution



Pre-Gabrielle (2013) TCS Evolution



Nondeveloping 2013 TCS Evolution



Discussion

Phase space distributions

- Most activity: 2005, least activity: 2013
- Low-level intensity tends to be greater than midlevel intensity in stronger systems
 - Consistent with formation of a warm core
- Little relationship between low- and midlevel flow organization
 - Slight preference for greater organization at low levels than at midlevels
- Low- and midlevel moisture are well correlated
- Average shallow-layer shear is near zero
- Stronger outflow with negative thermal vorticity
 - Matches expectation of anticyclonic outflow
- Moisture relationship appears stronger in 2010
 - Related to shear distribution?

Erin (2013) trajectories

- Depicts the system drying out and quickly spinning down
- Sudden change in alignment due to dissipation of midlevel circulation

Pre-Gabrielle (2013) trajectories

- CFSR appears to poorly handle pre-Gabrielle system
- Location is south of actual position
- CFSR indicates the system is steadily weakening at low levels despite developing

2013 Nondeveloping system trajectories

- Strongest midlevel feature changes
- Trajectories indicate system is slowly spinning down

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